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The spectrometer of gamma quantum GG-2M was placed on / 2*
ISZ "Kosmos-856" and "Kosmos-914", where it was used for the
measurement of the flow and energy spectrum of the diffuse
background of cosmic gamma radiation over the range of energies
from 100 MV to several GeV.

A detailed description of the apparatus GG-2M is given.
The spectrometer contains a Cerenkov and scintillation (including anticoincidence) counters. The energies of the gamma quan-
tums are measured by a shower calorimeter, in which scintilla-
tion counters are used in the capacity of detectors.

Results are given for tuning the device on mu-mesons of
cosmic rays. The data of physical tuning allow more reliable
interpretation of the results of measurements which are received
on the ISZ.

Introduction

In the Soviet Union on 22 September, 1976, and 31 May, / 3
1977, were launched the artificial satellites of the Earth (ISZ)¹

*Numbers in the margin indicate pagination in the foreign text.

¹Translator's note: ISZ stands for Iskusstvennyi Sputnik Zemli
or artificial satellite of the Earth.

"Kosmos-856" and "Kosmos-914", on board of which were placed spectrometers of gamma quantums of high energies GG-2M No. 1 and GG-2M No. 2, which were intended for the measurement of the flows and energy spectrum of the diffuse background of cosmic gamma radiation over the range of energies from 100 MV to several GeV.

The radiation of gamma quantums of high energy, which arise during the interaction of cosmic rays with gas, magnetic fields and electromagnetic radiation in galactic and metagalactic space, make it possible to receive information about the values which define them.

The main mechanisms of the formation of gamma rays with energies higher than 50MV in space is considered at the present time, the decay of π^0 mesons, which arise during the nuclear interaction of high-energy cosmic rays with interstellar gas, the braking radiation of electrons of high energies and Compton backscattering of electrons of high energies on photons of electromagnetic radiation. This does not disclude the possibility that a part of the observed gamma quantums of a diffuse background carry a relict characteristic, that is formed in an early stage of the evolution of the Universe. The diffuse background of gamma quantums contain two components: one which is collecting to a galactic surface, and an isotropic component which has a principal metagalactic origin.

The most reliable measurements of diffuse gamma radiation / 4 with energies higher than several MV in the area of high galactic latitudes, where the portion of isotropic gamma background is significant, were carried out on satellites "OSO-3" (1967-1968), "Kosmos-208" (1968) and SAS-2 (1973). In the experiment on the satellite "OSO-3" [1] only the integral flow of gamma quanta with energies higher than 100 MV was received. On the satellite "Kosmos-208" [2] measurements were made of the differential energy spectrum of gamma quanta over a wide range of energies - from 50MV to 200GeV, but these measurements have little statistical accuracy. In the experiment of SAS-2 [3], over a range of energies to 200MV, more precise values of intensity were received, which agreed with the results of "Kosmos-208". At the present time on satellite COS-B [4], launched in 1975, a study is being done of the flows of gamma quanta with the aid of a gamma telescope, which is capable of measuring the spectrum of gamma radiations with energies to several hundred MV, but the results of the measurement of the diffuse background are not published. As a result of the analysis of the data of the experiment of SAS-2, in the work [5] there was singled out an isotropic gamma flow with an energy spectrum which has a degree characteristic and indicator for a differential spectrum equal to 3.2 in the area of energies from 35 to 100MV. The large characteristic slope of the spectrum of the diffuse isotropic component imposes significant limits on the possible theoretic models which explain the origin of this radiation which

is forming. The degree spectrum of the gamma quanta, less rigid than those of the nucleon of primary cosmic rays, is answered only by the models of the rise of the isotropic background in discrete metagalactic sources with sufficiently sharp spectrums of high-energy electrons, and also by the baryon-symmetric metagalactic theories of "the big bang" [6], which suggest the creation of gamma quanta as a result of destructive interactions on the boundaries of hyperspace, of matter and antimatter, and which give anomalously sharp spectrums for gamma quanta also in the area of energies higher than 100MV. / 5

The spectrometer GG-2M contains a shower calorimeter of a thickness of eight radiational units, and allows spectral measurements to be made of gamma radiation up to energies at several GeV.

1. Description of the Operation and Construction of the Spectrometer

The constructions and electronic circuits of the two devices GG-2M, placed on different satellites, are basically analogous. There were introduced only several small corrections in the tuning of the detectors of the second model of the device based on the results of operation of the first model.

The principal diagram of the device is shown in Fig. 1. The spectrometer contains five coaxial detectors: a Cerenkov counter with a radiator of organic glass Ch (1) and convertor of gamma

quantums K (2), a scintillation counter S (3), a scintillation shower calorimeter E (4), which serves to measure the energies of gamma quantums, and scintillation detectors of anticoincidences A1 (5) and A2 (6), which guard the telescope from the background of charged particles.

The telescope of the two detectors Ch and S, which are switched on in coincidences, limits the angle of scan of the device, registering on charged particles which activate the operation of both detectors. The Cerenkov counter with a radiator, the face of which, being opposite the photomultiplier, is blackened, controls the direction of sensitivity. This is acheived due to the fact that the Cerenkov radiation of a charged particle radiates in a cone, the axis of which coincides with the direction of motion of the particle. For the particles which pass the radiator from the side of the photomultiplier, the Cerenkov radiation is absorbed by the blackened surface. Due to this, the telescope, which switches on the counter Ch, effectively registers only charged particles which pass across detector Ch from the side of the radiator (from the anterior hemisphere). The telescope also operates for gamma quantums which enter the device from the anterior hemisphere, registering electrons and positrons, which form in the matter of the convertor K in front of the Cerenkov counter. The division of instances of registration of the gamma quantums and charged particles which encounter the apparatus of the device, is carried out owing to the fact that

the latter, with a high effectiveness, are registered by the anticoincidence detectors which extend over the angle of scan of the device. Counter A2 guards the telescope counter Ch from charged particles also even on the side. The effectiveness of the interaction of gamma quanta in the material of the anti-coincidence detectors, having a small atomic weight, is small, and, consequently, in these detectors is also minor. The conversion of gamma quanta is carried out on the whole in the lead convertor of a thickness of one radiation unit. All the detectors of the device, excluding the counter A1, are placed within the hermetic container of the ISZ. During use of only the interior anticoincidence counter A2, in front of which, in the angle of scan of the device, is placed a sufficiently thick layer of material of the hermetic container, formation is possible of secondary gamma quanta by the charged particles in this layer. For the elimination of the imitations which are connected with this, of the registration of primary gamma quanta in the angle of scan of the device, outside the hermetic container is placed an additional detector A1, the outside wall of which contains a minimal amount of matter. Charged particles, passing detector Ch and S, penetrate detector E and actuate operation of the telescope of the three counters Ch, S and E. The scintillation shower calorimeter E acts as a "sandwich" of plates of tungsten alloy and a scintillator with a general thickness higher than eight radiational units. The electrons and protons, which are formed by gamma quanta, create in the plates of tungsten alloy

electron-photon showers. The amount of the scintillation flash in the calorimeter is proportional to the summated ionization losses and allows for evaluation of the energy of the primary gamma quantum.

Let us examine the construction of the individual detectors.

The outlying anticoincidence scintillation counter A1 contains a plate of scintillation plastic with the measurements $400 \times 400 \times 40 \text{ mm}^3$ and with tapers for the mounting of photomultipliers on two opposite lateral sides. The scintillation flashes are detected by four photomultipliers FEU-53 (7) (see Fig. 1) with the diameters of the photocathodes at 50 mm (with two photomultipliers on each side).

The inner anticoincidence scintillation counter A2 includes a scintillator made in the form of a cowl of complex form with maximal exterior measurement of $300 \times 300 \times 200 \text{ mm}^3$. The cowl contains a cylindrecal cavity and is scanned by four FEU-53 (8), placed along the edges of the two opposed exterior lateral sides. Between the scintillator and the photomultipliers an optical contact is realized.

The Cerenkov counter Ch is enclosed in the cylindrical cavity of detector A2 and has as a radiator a disk of organic glass with a diameter of 180 mm and a height of 40 mm with a conical taper from the side of the face which is turned to the photomultiplier. The disk from the face is scanned by a photomultiplier / 8

FEU-49 (9) with the diameter of the photocathode at 160 mm. An optical contact is provided for between either glass of the photomultiplier and the radiator. The face of the radiator opposed to the photomultiplier and half of its lateral surface, which is contiguous to this face, is matted and colored with a black matt paint. In the cylindrical cavity of scintillator A2 immediately in front of the radiator of the Cerenkov counter is placed a lead convertor of gamma quanta K, which is in the form of a disk with a diameter of 180 mm and a thickness of 5.6 mm (\approx 1 radiational unit of lead).

The scintillation counter S contains a disk of scintillation plastic with a diameter of 170 mm and a height of 15 mm. The lateral surface of the disk is scanned through light guides of organic glass by three photomultipliers FEU-84 (10) with photocathode diameters at 25 mm, placed symmetrically (at 120°) with regard to the center of the scintillator and perpendicular to its face surface. Between the scintillators and the light guides, and also the photomultipliers and the light guides an optical contact is provided.

The detector of energy of gamma quanta E represents a variation of the shower calorimeter on the scintillators and is made of plates of tungsten alloy VNDS, which contains 90% tungsten, ~10% copper and .06% nickel (mass of the alloy is 17.5 g/cm³), and plates of scintillation plastic. The plates of VNDS have a disk shape with a height of 4 mm and a diameter of 213,

226, 239, 240, 239, 239, 239 mm, respectively, beginning with the first disk. The plates from the scintillator have a thickness of 7 mm and a square section with the measurement of 260×260 mm². The plates of VNDS and of the scintillator are assembled in a coaxial stack, whereby the first two disks are placed against each other, and under each of the disks, beginning with the second, is placed a plate of the scintillator. The disks of VNDS are enclosed in frames of organic glass which fill / 2 the free space between the scintillation plates. The light from the scintillators is detected by four photomultipliers FEU-52 (11) with photocathode diameters of 80 mm, which are placed along the edges of the two opposing lateral sides of the plate stack. For uniform light collection, the photocathodes are placed symmetrically along the top of the stack relative to the first and last (seventh) plates of the scintillator.

In the device scintillators are used which are made of a plastic on the base of polystyrene (with the addition of paraterphenyl and ROROR). For the optical contact between the photomultipliers and the scintillators (or light guides), a methylxylostan glue is used. In order to improve the light collection, the surfaces of all the scintillators and the light guides, as well as the unblackened surface of the radiator of the Cerenkov counter are polished. In the counters A1 and A2 the polished surfaces which are not contiguous with the photocathodes of the photomultipliers are painted with a reflective enamel. In detec-

tor E between the plates of the scintillators and VNDS is placed a reflective film EVTI. The scintillators, radiator, light guides and photomultipliers of each detector are enclosed in a lightproof, rigid casing of duralumin. The inner surfaces of the casings are painted with a reflective enamel.

The detectors of the device A2, Ch, S and E are placed on board the ISZ in the hermetic container so that in front of the anticoincidence counter A2 in the angle of scan of the device, is found a layer of duralumin with a thickness $< 1.0 \text{ g/cm}^2$ ($\sim 2 \text{ mm Al}$). The outlying anticoincidence detector A1 is fastened outside the hermetic container and covers the angle of scan of the telescope. The input window of the outlying counter is made of a thin aluminum foil with a thickness of 0.1 mm.

2. Operation of the Logical Parts of the Electronics

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With the passage of charged particles across the scintillators, there arises in them Cerenkov and scintillation flashes, the intensities of which are proportional to the losses of the particles in ionization. These flashes are linearly reformed by the photomultipliers into electric signals. The elements of the electronics of the device bring about the logical processing of the electric impulses from the photomultipliers, the measurement of their amplitudes and the coding of the converted information for transmission of it for telemetering.

In Fig. 2 is shown the principal diagram of the part of the

electronic systems of the device.

The summated signals amplified by power and direction, from the photomultipliers of each detector are formed by discriminator-formers DF or by circuits without "dead" time, which include the circuits DF, formers F, and the summators of logical signals S. Formed signals appear further in the logical part of the electronics of the device in the circuits of double coincidence SDS, of triple coincidences STS, and circuits of anti-coincidence SA. With the aid of the combinations of coincidences and anticoincidences of signals from the various detectors, there is brought about an apportionment of instances of registration of gamma quantums on the background of charged particles as well as the formation of various auxiliary parameters.

Let us designate the symbol $A \cdot V$ as the coincidence at the time of the signals from detectors A and V, and the symbol $A \cdot \bar{V}$ - their anticoincidence (the signal from detector A is prohibited by the signal from detector V). Then, for example, the registrations of a charged particle, flying in the aperture of the telescope, will correspond to the parameter $Ch \cdot S \cdot E$, and registrations of a gamma quantum which passes detectors A₁ and A₂ without interaction and forms an electron-positron pair in convertor K is the combination of signals $Ch \cdot S \cdot E \cdot \bar{A}_1 \cdot \bar{A}_2$. Henceforth let us agree to designate $\bar{A}_1 \cdot \bar{A}_2 \equiv \bar{A}$, then the combination shown /11 above, which corresponds to a "gamma quantum" occurrence, takes on the form $Ch \cdot S \cdot E \cdot \bar{A}$.

The electrical impulses from the photomultipliers of detectors Ch, S, E, which coincide at times with the control signals from the logic block, are passed through by the linear key LK to the amplitude analyzer. Analysis of the signal from the detector lies in the transformation of the amplitude of this signal into a bundle of impulses, the number of which is proportional to its amplitude in a linear or logarithmic scale. The impulses from the counters Ch and S are analyzed by linear, 64-channel, amplitude analyzers LA with dynamic diaposons of measured amplitudes ~ 50, for which the 64 impulses at the exit of the analyzer correspond to the maximal amplitude. The impulses from detector E are analyzed by a logarithmic, 64-channel, amplitude analyzer EA with a dynamic diaposon ~ 100.

The information which is output to the telemetering system, includes in itself eighteen parameters, for each of which is further shown: the conventional signs, the decoding of the parameter as combinations of coincidences and anticoincidences of signals from the detectors and its physical sense.

GM and GB - $Ch \cdot S \cdot E \cdot \bar{A}$ - correspond to the registration of gamma quantums with energies higher than 100MV which pass in the physical angle of the device. With the formation of the parameter GM there is used a "slow" circuit of coincidences, and with the formation of GB - a "fast" circuit with a lesser execution time than GM.

ZARK - $Ch \cdot S \cdot E \cdot 1/K$ - characterizes charged particles which

are registered by the telescope of three counters of the device. The parameter ZARK is formed as a result of statistical recal- culation of the signal of triple coincidences Ch·S·E. In this instance the signals Ch·S·E move toward one of the inputs of /12 the circuit of double coincidences SDSZ (see Fig. 2), at another input of which appear, through the shaper DF, periodic impulses from the master generator ZG. The incidental coincidences of the impulses Ch·S·E and impulses from ZG give the signals ZARK, which are summated by the module S2 with the signals of GM, and together with them enter the control by the analyzers.

MG - Ch·S· \bar{E} · \bar{A} - corresponds to gamma quantums with energies less than 100MV, which are registered by the two detectors Ch and S and not registered by the counter E.

KG - Ch·S· \bar{E} · $\bar{A}2$ - is connected with the registration of gamma quantums with energies higher than 100MV, when, for the exclusion of charged particles, only detector A2 is used.

ACh, AS and AE - are evidence of the amplitude analyzers of the detectors Ch, S and E at the time of registration of gamma quantums or charged particles. In the capacity of control signals for the channels of energy analysis the signals GM + ZARK are used. The measurements of energy release from charged particles are necessary for the calibration of the channels of analysis.

$EA_1 - Ch \cdot S \cdot E \cdot A_2 \cdot \bar{A}_1$ - and $EA_2 - Ch \cdot S \cdot E \cdot A_1 \cdot \bar{A}_2$ - characterize the effectiveness of the registration of charged particles, which are passing the telescope of the device, by the anticoincidence detectors A_1 and A_2 respectively.

$ZAR - Ch \cdot S \cdot E$ - corresponds to charged particles which are registered by the telescope of three detectors.

$PE - Ch \cdot S \cdot \bar{E}$ - corresponds to charged particles of small energies (protons and electrons) which are registered by detectors Ch and S and not registered by counter E .

$S \cdot E \cdot \bar{A}$ - corresponds to charged particles which are registered by detectors S and E and not registered by the anticoincidence counters. /13

A_1 and A_2 - the speeds of calculation of impulses in the anticoincidence detectors A_1 and A_2 .

$Ch \cdot \bar{A}$, $S \cdot \bar{A}$ and $E \cdot \bar{A}$ - the speeds of calculation of impulses in the detectors Ch , S and E with the prohibition from the anticoincidence counters.

Consideration of these calculation speeds is necessary for the control of the stability of the operation of the detectors and, mainly, for the evaluation of the contribution of incidental coincidences in the calculation speed of "gamma quantum" instances. The prohibitions of registration of $\bar{A} = \bar{A}_1 \cdot \bar{A}_2$ in these

circuits is introduced in order that it be possible to count the number of incidental coincidences which imitate the registration of gamma quanta since only the impulses which are not accompanied by simultaneous operation of the detector A1 and A2, may cause such incidental coincidences.

The signals which are received as a result of the logical conversion of the impulses from the detectors, and also the bundles of impulses from the outputs of the channels of the amplitude analysis after the preliminary recalculation are transformed to a form suitable for transmission to the telemetering. In the device are used binary counters with a memory of 2^3 , each of which consists of three transformation trigger cells 3T, and a potential summator 3S, which gives eight discrete levels of command in a range of 0 to 6V, and also binary counters with a memory of 2^4 , which consist of 4 triggers 4T and summators 4S on 16 levels (see Fig. 2).

The signals GM, GB, ZARK, MG, EA1 and EA2 enter the eight-level summators, and the signals KG, ACh, AS ZAR, and PE - the sixteen-level summators. The parameter AE is transmitted to the telemetering with the aid of a six-discharge binary counter, which is capable of storing a maximal number of impulses from the 64-channel amplitude analyzer. In this instance the most recent three discharges output to the calculating channel AEM, /14 and the least recent three discharge - to the calculating channel AES. Both channels are terminated by conversion cells 3T and

eight-level summators 3S. In the channels ACh and AS, with the aid of the trigger cells 2T (see Fig. 2) there is introduced the preliminary conversion of 2^2 for impulses from the amplitude analyzers, as a result of which the number of impulses from each 64-channel analyzer is transformed to a number of exchanges between the levels of the corresponding, 16-level summator. In order that, in the case of great calculation speeds of charged particles in the channel ZAR, the memory of the binary counter is not overloaded, in it, with the aid of the unexamined trigger cells 6T, there is achieved a preliminary recalculation of 2^6 .

The parameters $S \cdot E \cdot \bar{A}$, A1, A2, Ch $\cdot\bar{A}$, S $\cdot\bar{A}$ and E $\cdot\bar{A}$ are output to the telemetering with the aid of linear ratemeters I (see Fig. 2), which convert the frequency of the direct current from 0 to 6V. The ratemeters are used with their own ranges of calculation speeds of registered impulses from 50 to 4000 Hz. To channels A2, A1 are included preliminary recalculations of 2^2 and 2^3 , which change the range of the ratemeters to 200-16000 Hz. in channel A2 and to 400-32000 Hz in channel A1. In the second model of the device a change was made in channels S $\cdot E \cdot \bar{A}$ and Ch $\cdot\bar{A}$ where the ratemeters were set at a calculation speed from 5 Hz to 400 Hz.

During the installation of the device on the satellite the sampling frequencies of its counter channel of the telemetering system were selected such that for the intervals of time between samplings the memories of the binary counters were not over-

loaded. During operation of the telemetering in the mode of short memory storage, the frequencies of sampling for the parameters GM, GB, ZARK, ACh, AS, AEM, AES equal 4 Hz, for parameters MG, KG - 2 Hz, and for all remaining, including the parameters with analogous outputs, - 1 Hz. In the mode of lengthy memory /15 storage all frequencies of sampling are decreased 10 times.

The electronics of the device fulfill several functions connected with the elimination of possible imitations of registration of gamma quantums by charged particles.

The registration of charged particles, in the course of renewal time of the impulse formers in the input circuits of the anticoincidence detectors is eliminated by the use of circuits without "dead" time, which consist of the discriminator-formers DF, formers F and logical summators S. In such a circuit the formed signals from the output of DF by a rear front activate F, in which the length of the output signal raises the time of renewal of the sensitivity of DF. The signals from the outputs of DF and F are summated by module S and at its output, at the intervals of time of the desensitivity of DF to input signal, a signal is present from F. For great reliability of elimination of charged particles the circuits without "dead" time in channels A1 and A2 are still duplicated.

Imitations of gamma quantums may also be caused by the products of the disintegration of mu-mesons stopping in the device,

which are caused as a result of the nuclear interaction of cosmic rays in the materials of the device. The lifespan of quiescent mu-mesons, equal to $2.2 \cdot 10^6$ s, increases the time of the circuits of coincidence, which form a gamma quantum event, and an appreciable probability of mu-meson disintegration is present after the operation of these circuits. An electron from a mu-disintegration may be registered by the telescope of the device, not having hit the anticoincidence detectors during this time, and in such a manner imitates a gamma quantum. For charged particles which pass the anticoincidence counters and form stopping mu-mesons, similar imitations partially eliminated on account of the increase of the length of the blocking impulses in channels /16 A1 and A2 to 2.5 and 6 microseconds, respectively. The furthest increase of these lengths is bounded by excessive increase of blocking of the device in the period of high calculation speeds of charged particles by the counters of A1 and A2. For the increase of analogous imitations of the parameter GM, the blocking signal from counter 3 is also increase to 8 mks. The lengths of all the remaining formers in the logical section of the electronics are set in a range from .5 to 1 mks.

With the goal of decreasing incidental coincidences of signals from the detectors of the telescope in the count of gamma quantum events, in the device the least permissible times are used as far as possible for the circuits of coincidence. In the first variant of the device the permissible times of the

circuits STS1, STS2, SDS1, SDS2 (see Fig. 2) were equal to, respectively, 600, 300, 150, 150 ns., and in the second variant they were decreased to 300, 150, 100, and 100 ns.

For the increase of reliability of the registration of the basic gamma quantum parameter GM, in the block of electronics the discriminator-formers and the circuit of triple coincidences which form this parameter were duplicated. With this, impulses from the duplicated circuits of coincidence STS1 and STS2 are summated by the module S1 and pass the circuit of anticoincidence SA, at the output of which are produced the signals GM, which enter further into the telemetering output and the control by means of the amplitude analyzers. With precise operation of both circuits of coincidence, their general permissible time equals the large permissible time of the circuit STS1.

The circuit STS2, which has two times less permissible time than the circuit STS1, is furthermore used for the formation of the signal G(ILLEGIBLE). The difference in the calculation speeds of the parameters GM and GB in this case is entirely dependant on incidental coincidences and is connected with /17 the differences in the values of the permissible times of the circuits of coincidence STS1 and STS2. This makes possible the direct evaluation of the calculation speed of incidental coincidences by both parameters GM and GB.

As shown earlier, impulses from the detectors of the tele-

scope enter the amplitude analysis through linear keys LK only in that case when, in the permissible inputs of LK there exist the signals GM + ZARK, which are received as a result of the summation of the signals GM and ZARK by the module S2. By means of the selection of the frequency of the signals from module ZG and the permissible time of the circuit of coincidences SDS3 the coefficient of statistical conversion for the parameter ZARK $K = \frac{ZARK}{ZAR}$ is set in a range $3 \cdot 10^{-4} + 3 \cdot 10^{-3}$ such that the calculation speed of the event ZARK does not raise the calculation speed of gamma quantum events GM. In order to protect the channels of analysis from incidental signals, the permissible times of the linear keys (the lengths of the permissible signals GM + ZARK) are selected as minimally possible and consist of 2 mks.

3. Physical Tuning of the Device

With the increase of several threshold values, the electric signals from the photomultipliers actuate the operation of the integral amplitude discriminators of the device, which make note of the registration by the detectors of charge particles. The physical tuning of the detectors is confined above all to the optimal choice of thresholds of the integral discriminators and modes of operation of the photomultipliers, during which the summated signals from the anode of the FEU detector from charged particles passing the telescope of the device reliably start the

amplitude discriminators with tolerable currents of high-voltage power and minimal noise loads of the photomultipliers. The decrease of noise loads allows the lowering of contributions of incidental coincidences of signals from the detectors on the strength of the telescope of the device. During operation on mu-mesons of cosmic rays which are formed by primary cosmic rays in the atmosphere, for each detector an amplitude distribution is received of the values of the electric signals from the various photomultipliers and the values of the summated signals from all the photomultipliers which arise during the passage in the physical angle of the device of individual, single-charge, relativistic particles. For the decrease of the expanse of amplitude distribution of the summated signal which characterize the energy resolution of the detectors, the photomultipliers of the various detectors were improved in sensitivity by means of the regulation of high-voltage power. As a result, the relative expanses of amplitude distributions for mu-mesons which pass the telescope, is set at .7 for detector Ch, .4 for detectors S and E and .5 for detectors A1 and A2. The threshold sensitivities of the detectors in units of the most probable energy releases from mu-mesons equal: .5 for detector Ch in a forward direction, .2 for detector S, .12 for detector E in the first variation of the device, .2 for detector E in the second variation of the device, .1 for detector A1 and .06 for detector A2. With the indicated threshold sensitivities the effectiveness of registration by detectors S, E,

A1 and A2 of relativistic single-charge, individual particles are close to 1. In view of the importance of the exclusion of charged particles by the anticoincidence counters for their effectiveness the registrations of mu-mesons which pass the telescope are defined precisely and equal $.998 \pm .0005$ for detector A1 and $.9994 \pm .0002$ for detector A2 in the first variation of the device. Simultaneous operation of the anticoincidence detectors allows the registration of mu-mesons with an effectiveness which exceeds .99993. The mean effectiveness of registration of mu-mesons flying in the aperture of the telescope by counter Ch in a forward direction is near .9 (for axial /19 mu-mesons it equals $.96 \pm .02$), and in a reverse direction it amounts to $.005 \pm .0025$ for the first variation of the device. For the telescope of three detectors, with the placement over it of a layer of lead with a thickness of 20 radiational units, which absorbs the soft component of cosmic rays, the calculation speed of the hard component of cosmic rays is determined. In the two variations of the device, the calculation speeds of the telescope, in the vertical position of its axis, are identical in the ranges of error and equal $.42 \pm .02$ Hz. The systematic measurements of the loads of the telescope and the various detectors allowed the control of the stability of the functioning of the device. Moreover, knowledge of the calculation speed by the telescope of mu-mesons during the calculation of the angular dependance of their intensity allows the evaluation of the effective geometric factor of the telescope for charged

particles, which approximately equals $50 \cdot \text{cm}^2 \cdot \text{sr}$.

The definition of integral flows and energy spectrums of gamma quantums according to their calculation speeds and energy releases which are registered by the device in space demands knowledge of such, for example, physical characteristics of the device, like the effective values of its geometric factor and energy release in the calorimeter for isotropic flows of gamma quantums of various energies. The experiments of the device by means of mu-mesons do not allow for reliable evaluation of /20 such characteristics. The best means of defining the physical parameters of the device during the registration by it of gamma radiation is the graation of it in bundles of "marked" gamma quantums in an accelerator. In connection with the absence of such bundles, calibrations of the device were carried out by means of electrons of high energy in the synchrotron FIAN SSSR. Such measurements make it possible to indirectly evaluate the parameters of the device during registration of gamma quantums. For electrons with energies of 100, 180, 310, 400 and 550 MV which enter the telescope at varying angles to its axis and the various parts of the surface, the effectivenesses of the telescope and energy losses in the various detectors is measured in part. According to the results of the preliminary processing from the experimental effectiveness of the registration by the telescope of the three counters Ch, S and E of electrons passing close to the axis of the device, which increases from

.05 ± .02 at 100MV to .5 ± .05 at 200MV, it is possible to tentatively evaluate the minimal energy of gamma quantums registered by the device at 100 - 150 MV.

4. Conducting of the Experiments on the ISZ

The apparatus GG-2M was placed on the artificial satellites of the Earth "Kosmos-856" and Kosmos-914". The overall measurements equal: 530 x 370 x 500 mm³ for the blocks of data units which are placed inside the hermetic container; 300 x 180 x 160 mm³ for the block of electronics which is situated inside the hermetic container and 700 x 420 x 142 mm³ for the outlying block of data units which is placed on the lateral surface of the satellite. The weight of the entire device does not exceed 90 kg., including the outlying block having a weight no greater than 16 kg. The device requires an electric power of not greater than 22 v. The outlying block of the device and the blocks found inside the hermetic container, normally functions in the ranges of temperatures of -10° + +45° C and 0° + +40° respectively. The device maintained operational capability /21 after vibration tests.

ISZ "Kosmos-856" and "Kosmos-914" were launched 22 September, 1976, and 31 May, 1977, respectively. The devices GG-2M normally functioned in the course of all operating times of the space apparatus in both flights (265 and 290 hours for "Kosmos-856" and "Kosmos-914", respectively). In Fig. 3, which illus-

trates the operation of the device GG-2M No. 1, the calculation speed is shown of the parameter ZAR for one orbit of the satellite around the Earth, which demonstrates the "latitudinal" dependance of the intensity of charged particles in space close to the Earth.

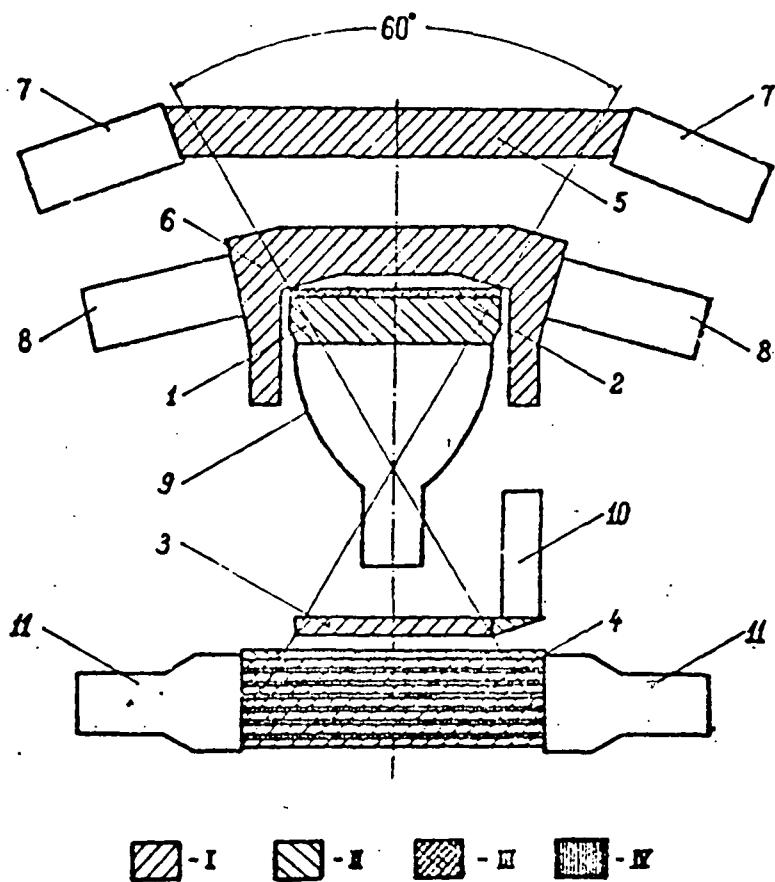


FIGURE 1 - Principal diagram of the spectrometer of gamma quanta GG-2M. 1- Cerenkov counter Ch, 2- Gamma quantum convertor K, 3- Scintillation counter S, 4- Scintillation shower calorimeter E, 5- Scintillation detector of anticoincidences A1, 6- Scintillation detector of anticoincidence A2, 7- Photomultipliers FEU-53, 8- Photomultipliers FEU-53, 9- Photomultipliers FEU-49, 10- Photomultipliers FEU-84, 11- Photomultipliers FEU-52, I- Scintillation plastic, II- Organic glass, III - Lead, IV- Alloy VNDS

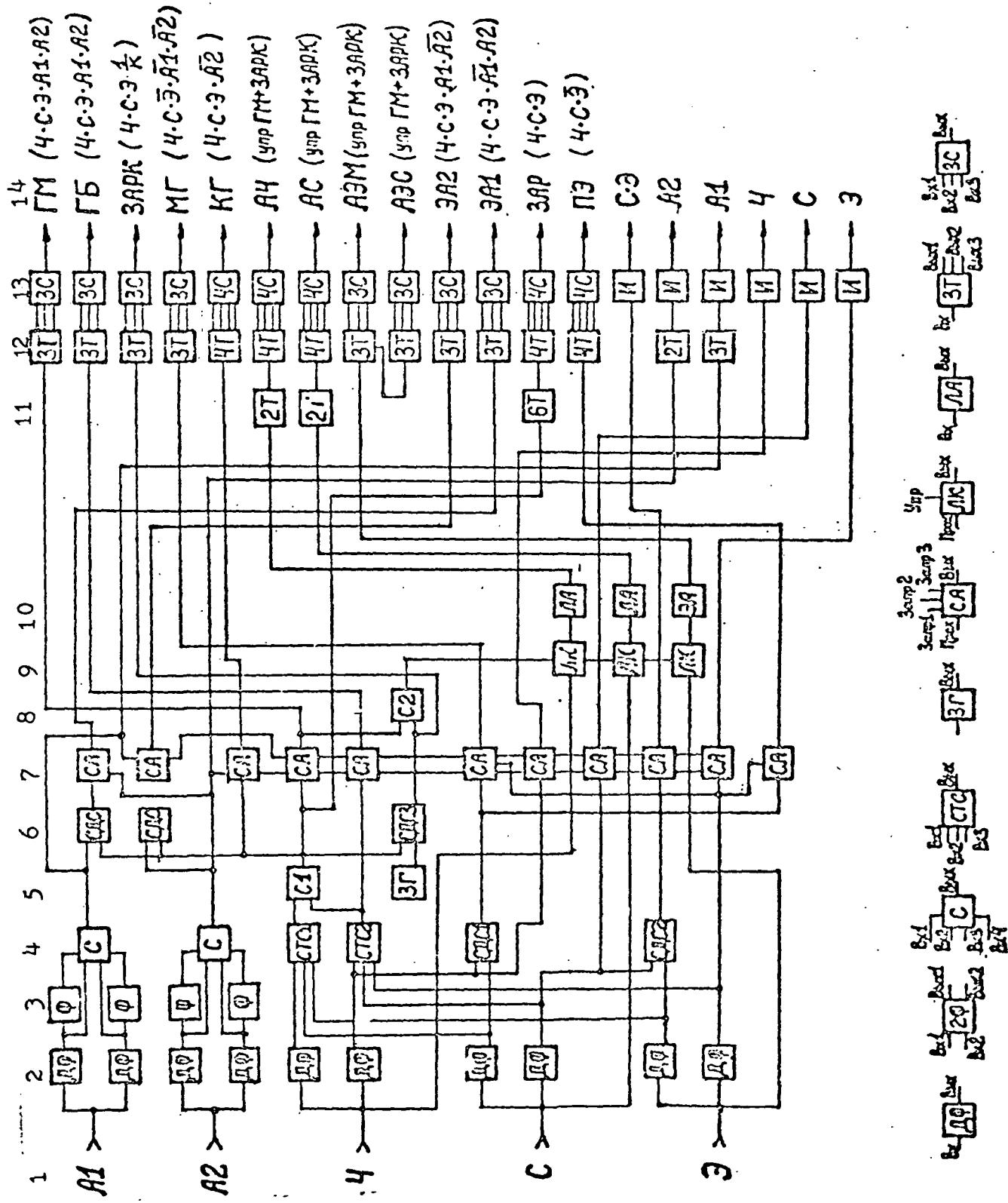


FIGURE 2 - Principal diagram of the electronics of the device GG-2M. Key found on following page.

Key to Figure 2.

From top to bottom

Column 1 - A1, A2, Ch, S, E

Column 2 - All boxes marked DF

Column 3 - All boxes marked F

Column 4 - S, S, STS1, STS2, SDS1, SDS2

Column 5 - S1, ZG

Column 6 - SDS, SDS, SDS3

Column 7 - All boxes marked SA

Column 8 - S2

Column 9 - All boxes marked LK

Column 10 - LA, LA, ZA

Column 11 - 2T, 2T, 6T

Column 12 - 3T, 3T, 3T, 3T, 4T, 4T, 4T, 3T, 3T, 3T, 3T, 4T, 4T, 2T, 3T

Column 13 - 3S, 3S, 3S, 3S, 4S, 4S, 4S, 3S, 3S, 3S, 3S, 4S, 4S, I, I, I, I, I, I

Column 14 - GM (Ch·S·E·A₁·A₂), GB (Ch·S·E·A₁·A₂), ZARK (Ch·S·E·¹K), MG (Ch·S·E·A₁·A₂), KG (Ch·S·E·A₂), ACh (con GM + ZARK), AS (con GM + ZARK), AEM (con GM + ZARK), AES (con GM + ZARK), EA2 (Ch·S·E·A₁·A₂), EA1 (Ch·S·E·A₁·A₂), ZAR (Ch·S·E), PE (Ch·S·E), S E, A2, A1, Ch, S, E

The lower boxes are from left to right: DF, 2F, S, STS, ZG, SA, LK, LA, 3T, 3S. The left side of the box indicates the number of inputs, the right side - outputs. The box SA also shows connections, LK the control connection.

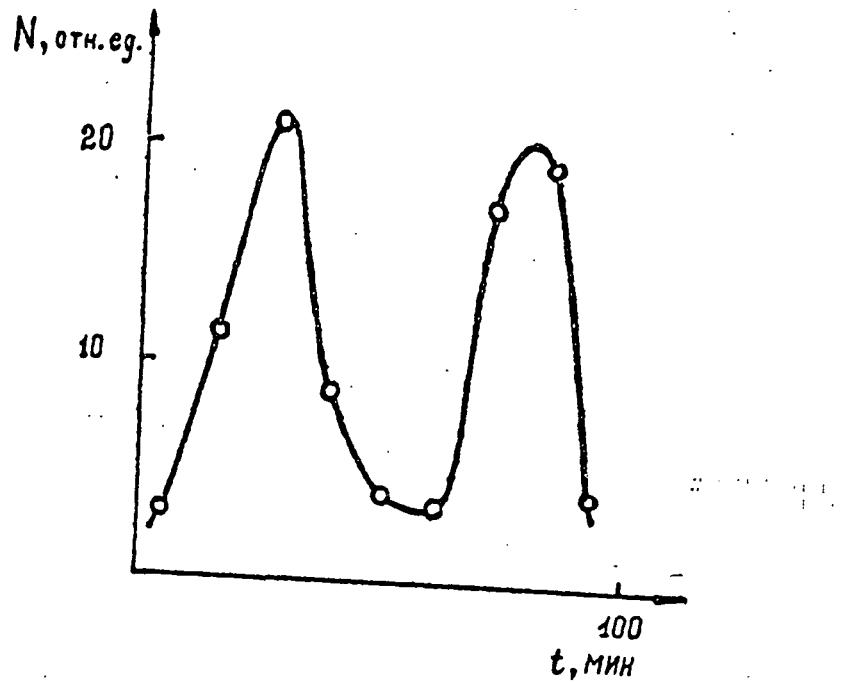


FIGURE 3 - Calculation speed by the device of charged particles on an orbit of ISZ "Kosmos-856". The vertical axis is I in relative units, the horizontal - time in minutes.

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16. Abstract A detailed description of the apparatus GG-2M is given. The spectrometer contains a Cerenkov and scintillation (including anticoincidence) counters. The energies of the gamma quanta are measured by a shower calorimeter, in which scintillation counters are used in the capacity of detectors. Results are given for tuning the device on mu-mesons of cosmic rays. The data of physical tuning allow more re- liable interpretation of the results of measurements which are received on the satellites.			
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